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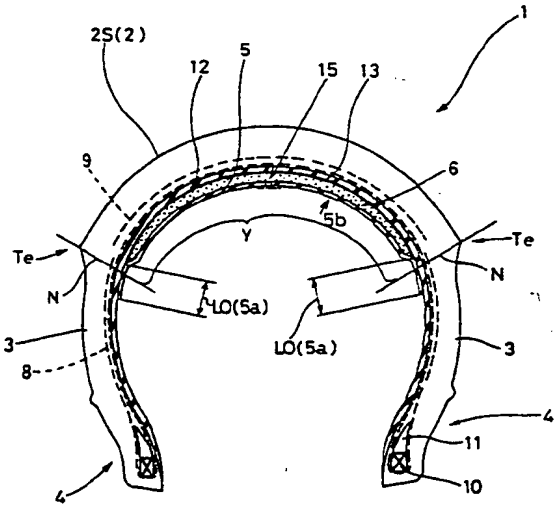
## (54) PNEUMATIC TIRE AND PRODUCTION METHOD THEREOF

(57) A pneumatic tire 1 has a toroidal shape in which a bead portion 4 is provided at an inner end of a sidewall portion 3 extending radially inwardly from each end of a tread portion 2, and a puncture sealant 6 is sealed with a packing rubber sheet 5 extending circumferentially at the inner surface of the tire in the tread portion 2. The packing rubber sheet 5 has bonded parts 5a defined as both side edge parts bonding together with the inner liner rubber 12 at the inner surface of the tire, and an unbonded part 5b between the bonded parts 5a which part is prevented from bonding with the inner liner rubber 12 by an anti-adhesive sheet 13 having a separating effect disposed therebetween. The sealant 6 is sealed in a bag-like portion between the inner liner rubber 12 and packing rubber sheet 5 which is defined by the unbonded part 5a.

Fig.1




EP 1 034 916 A1

## Description

### Technical Field

**[0001]** The present invention relates to a tube-less pneumatic tire and a method of manufacturing a pneumatic tire being capable of preventing air leakage from punctures caused in the tread portion by nails and the like.

### Background Art

**[0002]** As one of methods for preventing air leakage from a puncture caused by nail and the like, for example as disclosed in the laid-open Japanese patent application JP-A-8-323875, it has been proposed that a bag-like portion is formed between an inner liner rubber facing the tire inner cavity and a packing rubber sheet provided outside thereof, and a puncture sealant is injected into the bag-like portion by an injector or the like after the vulcanization of the tire is completed.

**[0003]** This bag-like portion is an unbonded part formed as follows. In arranging the packing rubber sheet and inner liner rubber one upon the other during making a raw tire, a powdery or liquid mold-release agent such as talc and the like is applied to the inner surface of the packing rubber sheet with leaving both edge parts not applied so that the edge parts of the packing rubber sheet are bonded to the inner liner rubber during vulcanizing but the part to which the mold-release agent was applied is not bonded.

**[0004]** In the bag-like portion formed by applying the mold-release agent, there is a tendency for the mold-release agent to be applied more than enough, which decreases the area of the bonded part of the packing rubber sheet, and as a result, the bonding strength decreases. Thus, it is difficult to stably make a bag-like portion having a necessary strength. Further, the operation for applying the mold-release agent decreases the efficiency, and often, due to uneven spread of the mold-release agent, bonded spots are formed in the bag-like portion and the injected puncture sealant becomes uneven.

### Disclosure of the Invention

**[0005]** It is an object of the present invention to provide a pneumatic tire and a method of manufacturing a pneumatic tire, in which a bag-like portion (unbonded part) having a sufficient bonding strength can be made easily and stably, and thus a high-quality tire including an injected sealant can be manufactured efficiently with a high available percentage.

**[0006]** In the present invention, in order to achieve the object, there is provided a pneumatic tire having a toroidal shape in which a bead portion is provided at an inner end of a sidewall portion extending radially inwardly from each of a pair of ends of a tread portion, and characterized in that

a puncture sealant is sealed with a packing rubber sheet extending circumferentially at the inner surface of the tire in the tread portion,
the packing rubber sheet has

side edge parts bonded to an inner liner rubber disposed along the inner surface of the tire, and
an unbonded part between the bonded parts, not bonded to the inner liner rubber by disposing an anti-adhesiv sheet having a separating effect, and

the sealant is sealed in a bag-like portion defined by the unbonded part between the inner liner rubber and packing rubber sheet.

**[0007]** Further, in the present invention, there is provided a method of manufacturing a pneumatic tire in which a puncture sealant is sealed with a packing rubber sheet extending circumferentially at the inner surface of the tire, and the method comprises

a sheet-piercing step in which a packing rubber sheet provided with an injecting hole for injecting the sealant is formed by piercing the hole in the packing rubber sheet,
a fitting step in which the packing rubber sheet is applied onto a shaping former,
an anti-adhesive sheet applying step in which the packing rubber sheet with an anti-adhesive sheet having a width narrower than the packing rubber sheet is formed by applying the anti-adhesive sheet to the upper surface of the packing rubber sheet while positioning both side edges of the anti-adhesive sheet equidistantly from both side edges of the packing rubber sheet,

an inner liner rubber applying step in which an inner liner rubber is applied to the upper surface of the packing rubber sheet,

a raw cover forming step in which a raw cover is formed by adding tire-main-body components including a carcass and bead cores onto the inner liner rubber and by expanding, and

an injecting step in which a sealant is injected, after the raw cover is vulcanized, from the injecting hole into an unbonded part between the inner liner rubber and packing rubber sheet prevented from bonding due to the anti-adhesive sheet.

**[0008]** For the anti-adhesive sheet, a she et of polyfluoroethylene resin is preferably used because the anti-adhesive sheet can expand or contract according to the expansion of the tire during vulcanizing, shaping or the like, and thus the packing rubber sheet can be certainly prevented from tearing.

Brief Description of the Drawings

**[0009]**

Fig.1 is a cross sectional view showing an embodiment of the pneumatic tire.

Fig.2 is a diagram for explaining the sheet-piercing step.

Fig.3(A) is a diagram for explaining the fitting step. Fig.3(B) is a diagram for explaining the anti-adhesive sheet applying step.

Fig.4(A) is a diagram for explaining the inner liner rubber applying step. Fig.4(B) is a diagram for explaining the raw cover forming step.

Fig.5 is a diagram for explaining the injecting step.

The Best Mode of Carrying out the Invention

**[0010]** Taking the case of a motorcycle tire, an embodiment of the pneumatic tire of the present invention and an embodiment of the manufacturing method of the present invention will now be described in conjunction with the drawings.

**[0011]** Fig.1 exemplarily shows a motorcycle tire 1 (hereinafter tire 1), wherein a bead portion 4 is provided at an inner end of each of sidewall portions 3 each extending radially inwards from one of a pair of ends of a tread portion 2. Thus, the tire 1 is toroidal. And a puncture sealant 6 is sealed with a packing rubber sheet 5 which extends circumferentially at the inner surface of the tire in the tread portion.

**[0012]** Further, the tire 1 is reinforced by cord layers including a carcass 8 extending between the bead portions 4 and a breaker 9 disposed radially outside the carcass 8 in the tread portion 2 to provide a necessary tire strength and rigidity.

**[0013]** In the bead portion 4, a bead apes rubber 11 having a triangular sectional shape extending radially outwardly from a bead core 10 is disposed to increase the bead rigidity.

**[0014]** For the carcass 8, there is used at least one carcass ply having a radial or semi-radial structure in which carcass cords are arranged at an angle of from 70 to 90 degrees, or a bias structure in which carcass cords are arranged at an angle of from 35 to 70 degrees, with respect to the circumferential direction. Both ends of the carcass ply are turned up around the bead cores 10 to be secured thereto.

**[0015]** The breaker 9 is composed of at least one ply, usually plural plies of breaker cords laid at an angle of from 0 to 70 degrees with respect to the circumferential direction. It is however possible to remove the breaker 9 if so required by the desired tire performance.

**[0016]** On the inner surface of the carcass 8, an inner liner rubber 12 and a packing rubber sheet 5 are disposed in that order. The inner liner rubber 12 is composed of a gas-impermeable butyl rubber compound such as butyl rubber, halogenated butyl rubber or the like, and it has a substantially constant thickness of from 0.5 to 2.0 mm and covers all over the inner surface of the carcass 8.

**[0017]** The packing rubber sheet 5 in this embodiment is a band-like rubber sheet which has a width of not less than 80% of a tread inside region Y and extends continuously in the circumferential direction. It is provided in each of side edge portions with a bonding part 5a to be bonded with the inner liner rubber 12 by vulcanization for example. The width L0 of each bonding part 5a is, for example, 4.0 to 10.0 mm, preferably 5.0 to 7.0 mm. When the width L0 of the bonding part 5a is less than 4.0 mm, the bonding strength is liable to become insufficient. When more than 10.0 mm, the width of the injected sealant 6 is decreased more than is necessary. The above-mentioned "tread inside region Y" is a region in the inner surface of the tire extending between normal lines N and N drawn to the tread face 2S at the tread edges Te.

**[0018]** Preferably, the packing rubber sheet 5 has a thickness of from 0.5 to 2.0 mm for example. If the thickness is less than 0.5 mm, the strength is insufficient for protecting the sealant, and it becomes difficult to evenly apply the tire

inflation pressure to the sealant. If more than 2.0 mm, the weight undesirably increases. Accordingly, it is more preferable that the thickness is 1.0 to 1.5 mm. For the packing rubber sheet 5, a butyl rubber compound which is substantially same as the inner liner rubber 12 is preferably used. Also brominated butyl rubber or halogenated butyl rubber can be used. Further, rubber compounds containing diene rubber such as styrene butadiene rubber and the like can be used as far as it can be bonded by the heat during vulcanization.

**[0019]** Between the bonding parts 5a of the packing rubber sheet 5, an unbonded part 5b is formed by disposing an anti-adhesive sheet 13 between the packing rubber sheet 5 and the inner liner rubber 12 to prevent these from bonding together. In a bag-like portion defined as the unbonded part 5b between the inner liner rubber 12 and the packing rubber sheet 5, the sealant 6 is sealed and is secured air-tightly in this example.

**[0020]** The sealant 6 is liquid at a normal temperature (20 degrees C). For example, a viscous material having a coefficient of viscosity in the range of from 2.0 to 10.0 mPa・s (temperature 20 deg. C) is suitably used. But, various fluid puncture sealants can be used as far as a hole caused by nail can be sealed up therewith in a temperature range of from minus 20 to plus 60 degrees C.

**[0021]** The anti-adhesive sheet 13 is a band-like body which is about 8 to 20 mm narrower in width than the packing rubber sheet 5 and which is made of a material having a separating effect with respect to at least rubber. It is preferable that the anti-adhesive sheet 13 has an elongation property such that it can elongate following the surrounding rubber during making a raw tire and during vulcanizing. Therefore, it is especially preferable to set the elongation at a load of 400 grams per 8 mm sheet width in a range of not less than 20 %.

**[0022]** In this embodiment, Teflon (Du Pont's trademark) or polyfluoroethylene resin is used, and a necessary elongation property is provided by setting the thickness in a range of from 0.05 to 0.15 mm (for example 0.1 mm). If the above- mentioned elongation is less than 20 %, there is a possibility that the packing rubber sheet 5 is torn during making the raw tire or during vulcanizing. Although the polyfluoroethylene resin sheet is especially suitable for the anti-adhesive sheet, its cost is high. Therefore, a low cost material such as a nylon film is used. For such nylon film, one including nylon-6 as a main material (for example, "RAYFAN NO" a tradename of TORAY SYNTHETIC FILM COMPANY) is especially suitable. Table 1 shows physical properties of this nylon film.

Table 1

| Item | Unit | Value | Measuring method |
|---|---|---|---|
| Density | g/cu.cm | 1.13 | Density gradient tube method |
| Melting point | deg.C | 215 | |
| Tensile strength | kg/sq.mm | 6 to 9 | ASTM-D882 |
| Elongation | % | 300 to 400 | ASTM-D882 |
| Young's modulus | kg/sq.mm | 45 to 55 | ASTM-D882 |
| Tear strength | g | 50 to 60 | ASTM-D1922 |
| Impact strength | kg-cm/mm | 1600 | Drop ball impact method |
| Moisture permeability | g/sq.m day 0.1mm | 60 to 80 | JIS-Z208 40 deg.C RH 90% |
| Oxygen transmittance | c.c./sq.m day atm 0.1mm | 6 | ASTM-D1434 20 deg.C dry |
| Haze | % | 4 to 6 | JIS-K6718 |
| Coefficient of static friction | - | 0.5 to 0.7 | |
| (30 micron, 20 deg.C, 65% RH) | | | |

**[0023]** From the results of various tests conducted by the inventors, it was confirmed that the anti-adhesive sheet made of such nylon film can display a good separating effect and elongation performance even if the thickness is decreased to for example about 25 micrometers.

**[0024]** Next, a method of manufacturing the tire 1 will be explained.

**[0025]** The manufacturing method in this embodiment comprises a sheet-piercing step P1, a fitting step P2, an anti-adhesive sheet applying step P3, an inner liner rubber applying step P4, a raw cover forming step P5, and an injecting step P6.

**[0026]** In the sheet-piercing step P1 (schematically shown in Fig.2), a packing rubber sheet 5A provided with a hole for injecting the sealant 6 is formed by piercing the hole 15 in the packing rubber sheet 5 which is being cut or has been cut into a specific width and a specific length. In this embodiment, the injecting hole 15 having a diameter of 2 to 8 mm

is provided in the central portion of the packing rubber sheet 5 in the widthwise direction.

[0027] In the fitting step P2 (schematically shown in Fig.3(A)), the packing rubber sheet 5A is applied to a shaping former 20 in a position thereon which corresponds to the above-mentioend tread inside region Y.

[0028] In the anti-adhesive sheet applying step P3 (schematically shown in Fig.3(B)), a packing rubber sheet 5B with an anti-adhesive sheet thereon is formed by applying the anti-adhesive sheet 13 to the upper surface of the packing rubber sheet 5A so that both side edges of the anti-adhesive sheet 13 are placed at certain positions each spaced apart from one of side edges of the packing rubber sheet 5A by a distance equal to the width L0.

[0029] In the present invention, therefore, the step in the prior art to apply the mold release agent is replaced by a very simple work to apply the anti-adhesive sheet 13 having a constant width and a constant thickness to the packing rubber sheet 5.

[0030] In the inner liner rubber applying step P4 (schematical ly shown in Fig.4(A)), the inner liner rubber 12 is applied to the upper surface of the packing rubber sheet 5B provided with the anti-adhesive sheet thereon.

[0031] In the raw.cover forming step P5 (schematically shown in Fig.4(B)), a raw cover 1A is formed by adding tire-main-body components 16 including a carcass 8 and bead cores 10 onto the inner liner rubber 12, and by expanding by the shaping former 20. In this embodiment, the tire-main-body components 16 further includes a bead apex rubber 11, a breaker 9, a tread rubber 2G, and a sidewall rubber 3G. And both ends of the carcass 8 are turned up before expanding.

[0032] The injecting step P6 (schematically shown in Fig.5) is a step to be done after vulcanizing the raw cover 1A, in which the sealant 6 is injected from the injecting hole 15 into an unbonded part 5b between the inner liner rubber 12 and the packing rubber sheet 5 where these are prevented from bonding by the anti-adhesive sheet 13, and there is formed a sealant layer swelled to a specific thickness by the injection in a given quantity by means of an injector like a syringe. In this embodiment, after the injection, the hole 15 is closed with a sheet of unvulcanized or vulcanized rubber and the like to which an adhesive agent is applied.

[0033] As described above, in the method of manufacturing the pneumatic tire in this embodiment, the anti-adhesive sheet having a constant width and a constant thickness is applied to the packing rubber sheet 5 instead of applying the mold release agent. Therefore, the efficiency is improved, and it becomes possible to accurately control the width L0 of the bonding part 5a on each side. As a result, the bonding strength of the bag-like portion can be increased and stabilized. And the width of the unbonded part 5b and the volume of the bag-like portion into which the sealant is injected are evened. Thus, a pneumatic tire in which the thickness of the sealant layer is evened can be obtained.

[0034] Further, the separation failure due to uneven spread of the mold release agent can be fully prevented. Furthermore, because the injecting bole 15 is provided in the packing rubber sheet 5 in advance to insert the tip of the injector to inject the sealant 6 and the anti-adhesive sheet 13 can protect the inner liner rubber 12, the inner liner rubber 12 is prevented from being wounded. Thus, as explained above, high-quality tires can be efficiently manufactured at a high available percentage.

Working Example

[0035] Motorcycle tires of size 3.00-10 having the structure shown in Fig.1 were experimentally made according to the above-mentioned manufacturing method. The sheet materials shown in Table 2 were used as the anti-adhesive sheet, and the tire qualities were compared. As to the dimensions of the sheet, Example 1 was 140 mm in width, 760 mm in length and 0.1 mm in thickness. Example 2 was 140 mm in width, 1500 mm in length and 0.025 mm (25 micron) in thickness.

Table 2

| | Anti adhesive sheet | Result of Manufacturing |
|---|---|---|
| Ref.1 | Cellophane | Raw cover could be made and Vulcanization was possible, but Unbonded part was not formed because it has no anti-adhesive effect. |
| Ref.2 | Ordinary paper | Row cover could be made, but Packing rubber sheet was torn during vulcanizing |
| Ref.3 | Tracing paper | Row cover could be made, but Packing rubber sheet was torn during vulcanizing |
| Ref.4 | Teflon tape with fibers | Packing rubber sheet was torn during making Raw cover |
| Ex.1 | Teflon tape | Packing rubber sheet was not torn and Unbonded part could be formed with accuracy |
| Ex.2 | Nylon film | Packing rubber sheet was not torn and Unbonded part could be formed with accuracy |

[0036] As shown by Table 2, the bag-like portion could be formed efficiently and air-tightly in Example tires 1 and 2 in which Teflon sheet or nylon sheet having a separating effect and an extensibility was used as the anti-adhesive sheet.

[0037] As explained above, in the pneumatic tire of the present invention, the packing rubber sheet for sealing the sealant has the bonded parts fused together with the inner liner rubber, and the unbonded part prevented from bonding to the inner liner rubber by the anti-adhesive sheet having a separating effect and disposed between the bonded parts. And the sealant is sealed in the bag-like portion defined as the unbonded part between the inner liner rubber and packing rubber sheet. Therefore, an accurate pneumatic tire can be obtained in which the volume of the bag-like portion into which the sealant is injected is evened and the thickness of the sealant layer is evened.

[0038] In the manufacturing method according to the present invention, the anti-adhesive sheet having a constant width and a constant thickness is applied to the packing rubber sheet instead of applying the mold release agent. Therefore, the efficiency is improved, and it becomes possible to control the width of the bonding parts in the both edges of the packing rubber sheet with a high-precision. As a result, it becomes possible to easily manufacture such a pneumatic tire that the bonding strength of the bag-like portion is increased and stabilized, and the width of the unbonded part and the volume of the bag-like portion into which the sealant is injected are evened, and the thickness of the sealant layer is evened.

## Claims

1. A pneumatic tire having a toroidal shape in which a bead portion is provided at an inner end of a sidewall portion extending radially inwardly from each end of tread portion, characterized in that

   a puncture sealant is sealed with a packing rubber sheet which extends circumferentially at the inner surface of the tire in the tread portion,
   the packing rubber sheet has

   bonded parts defined as the both side edge parts bonding together with an inner liner rubber disposed along the inner surface of the tire, and
   an unbonded part between the bonded parts which is prevented from bonding with the inner liner rubber by an anti-adhesive sheet having a separating effect and disposed therebetween,

   a sealant is sealed in a bag-like portion between the inner liner rubber and the packing rubber sheet which is defined by the unbonded part.

2. A method of manufacturing a pneumatic tire in which a puncture sealant is sealed with a packing rubber sheet extending circumferentially at the inner surface of the tire, wherein the method comprises

   a sheet-piercing step in which a packing rubber sheet provided with an injecting hole for injecting the sealant is formed by piercing the hole in the packing rubber sheet,
   a fitting step in which the packing rubber sheet is applied onto a shaping former,
   an anti-adhesive sheet applying step in which the packing rubber sheet with an anti-adhesive sheet is formed by applying the anti-adhesive sheet to the upper surface of the packing rubber sheet, the anti-adhesive sheet being narrower in width than the packing rubber sheet, and both side edges of the anti-adhesive sheet are located at positions which are spaced apart from both side edges of the packing rubber sheet by the same distance,
   an inner liner rubber applying step in which an inner liner rubber is applied to the upper surface of the packing rubber sheet,
   a raw cover forming step in which a raw cover is formed by adding tire-main-body components including a carcass and bead cores onto the inner liner rubber and by expanding,
   an injecting step in which the sealant is injected, after vulcanizing the raw cover, from the injecting hole into an unbonded part between the inner liner rubber and packing rubber sheet where these are prevented from bonding by the anti-adhesive sheet.

3. The method of manufacturing a pneumatic tire according to claim 2, wherein the anti-adhesive sheet is made of a polyfluoroethylene resin.

# Fig.1

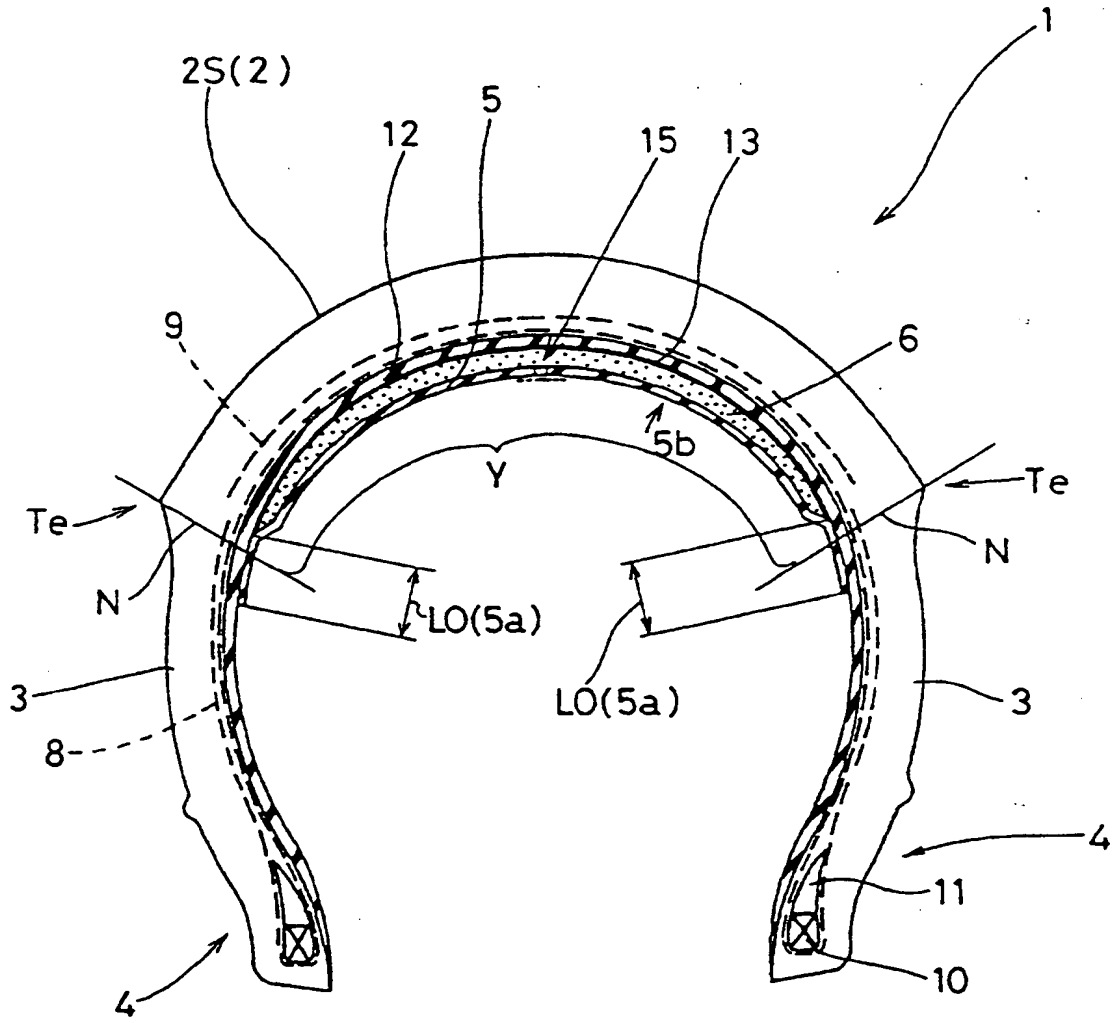
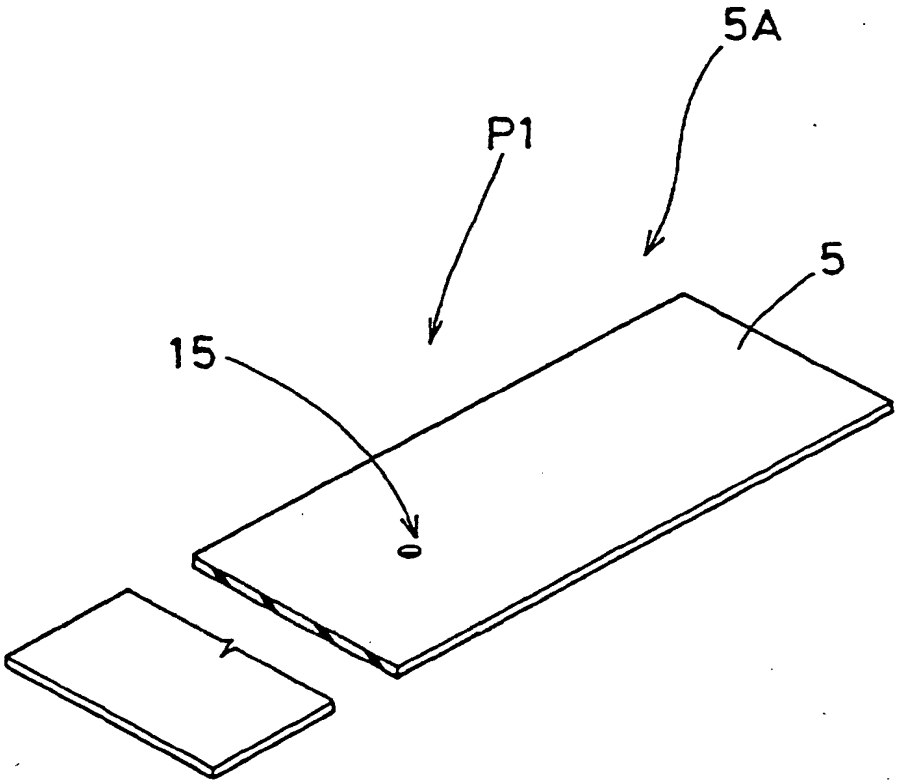
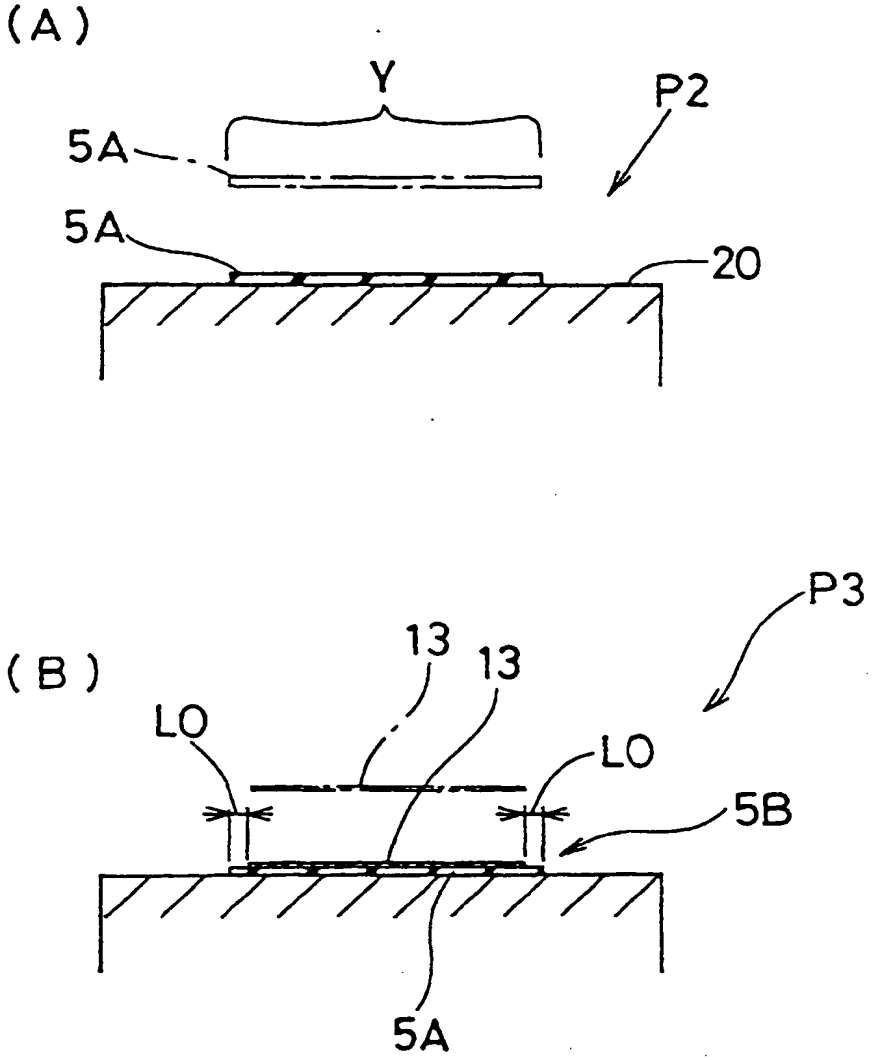


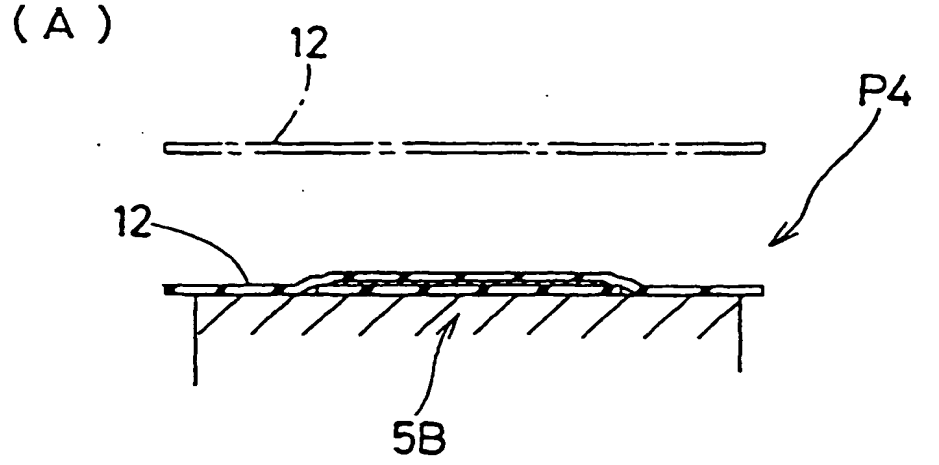
Fig.2

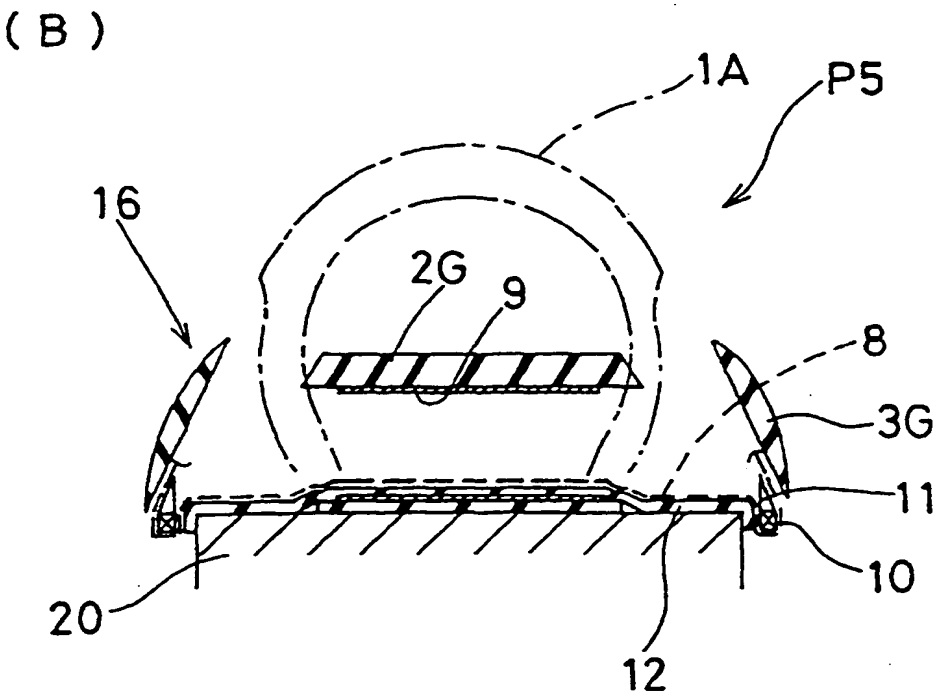


# Fig.3

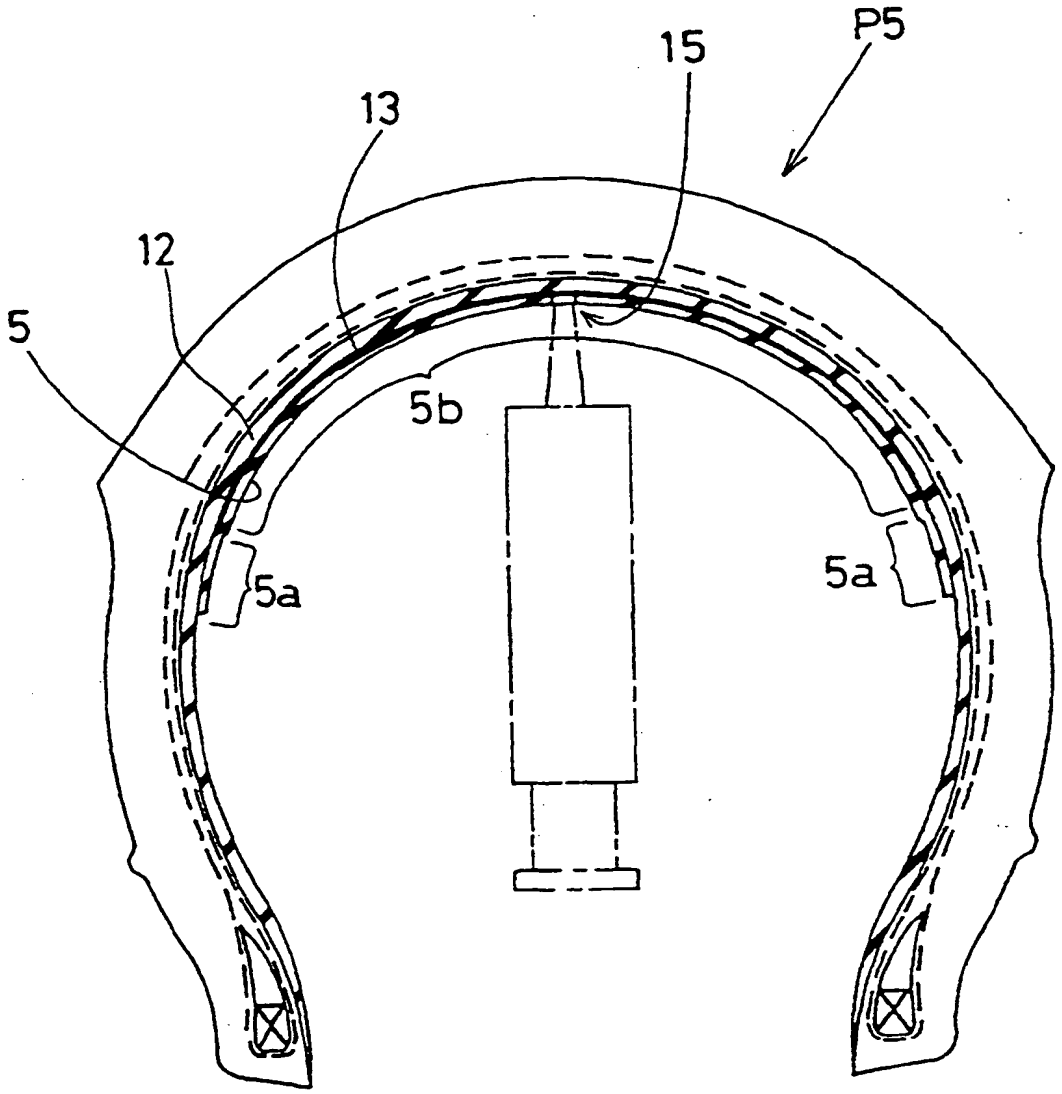


# Fig.4



# Fig.5



# INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/05343

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[6] B29D30/08, B60C19/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[6] B29D30/00-30/72, B60C19/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-1999
Kokai Jitsuyo Shinan Koho 1971-1999 Jitsuyo Shinan Toroku Koho 1996-1999

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | JP, 8-323875, A (Honda Motor Co., Ltd.), 10 December, 1996 (10. 12. 96), All references (Family: none) | 1-3 |
| A | JP, 51-21034, B (Bridgestone Tire Co., Ltd.), 29 June, 1976 (29. 06. 76), All references (Family: none) | 1-3 |
| A | JP, 9-300481, A (Honda Motor Co., Ltd.), 25 November, 1997 (25. 11. 97), All references & WO, 98/8670, A | 1-3 |
| A | JP, 60-8103, A (Polysar Ltd.), 17 January, 1985 (17. 01. 85), All references & CA, 1217122, A & EP, 127998, A & ES, 8506505, A | 1-3 |
| A | JP, 49-30279, B (Bridgestone Tire Co., Ltd.), 12 August, 1974 (12. 08. 74), All references (Family: none) | 1-3 |

[x] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 22 February, 1999 (22. 02. 99) | 9 March, 1999 (09. 03. 99) |
| Name and mailing address of the ISA/ Japanese Patent Office | Authorized officer |
| Facsimile No. | Telephone No. |

Form PCT/ISA/210 (second sheet) (July 1992)

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/05343

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | JP, 63-232004, A (National Tire Co., Ltd.), 28 September, 1988 (28. 09. 88), All references (Family: none) | 1-3 |

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

# Fig.1

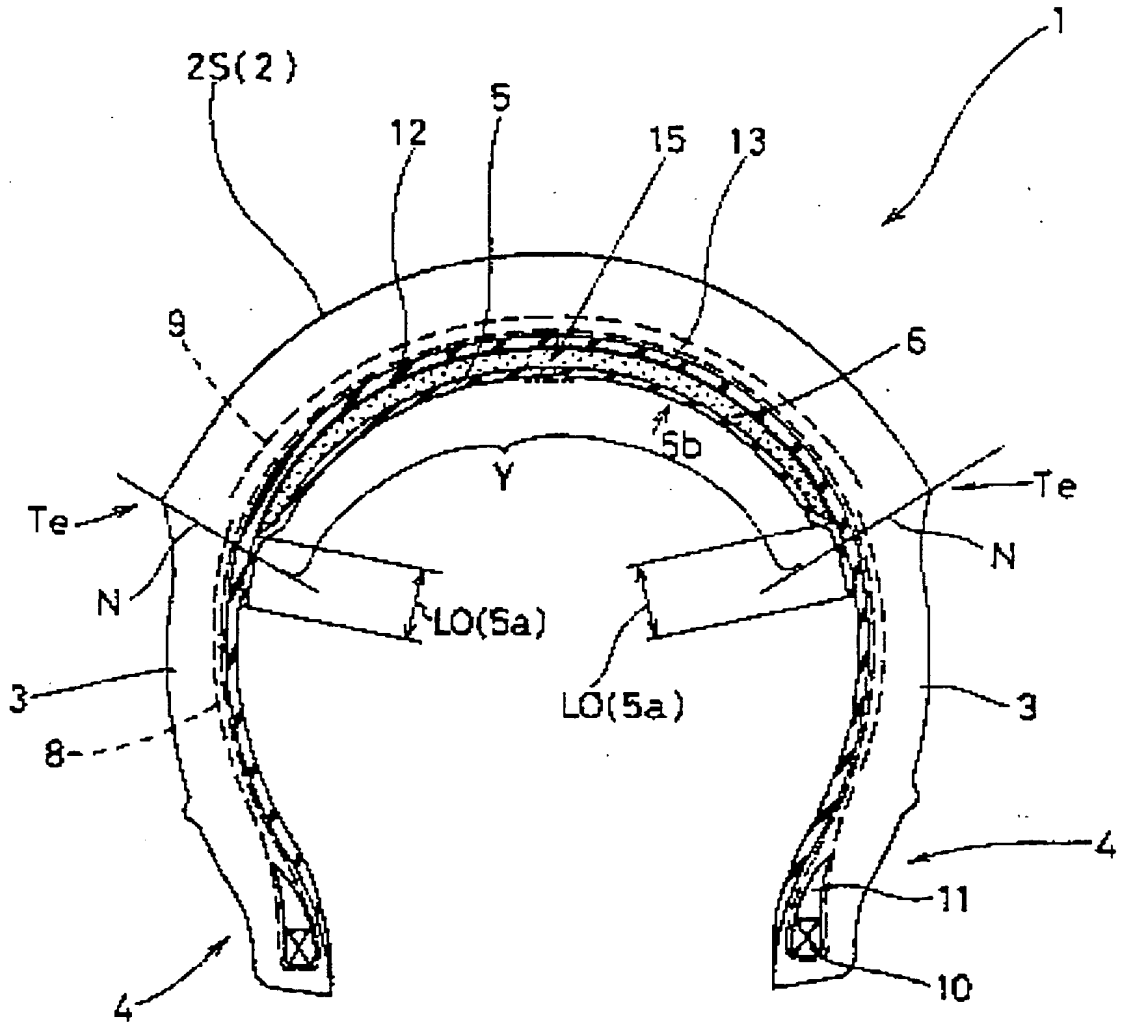
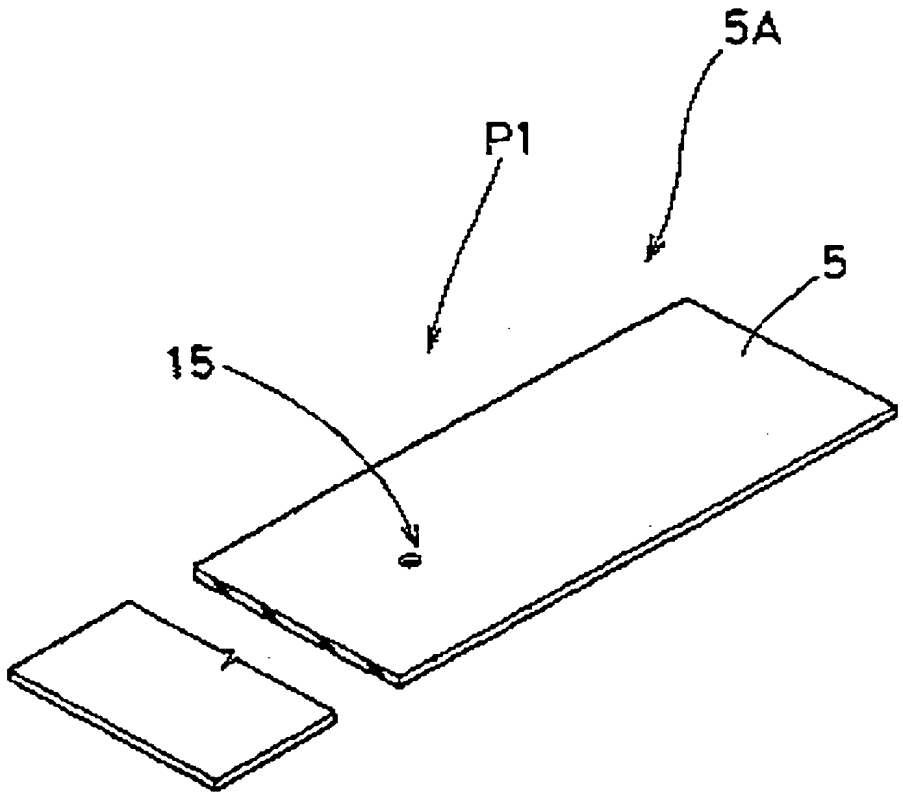
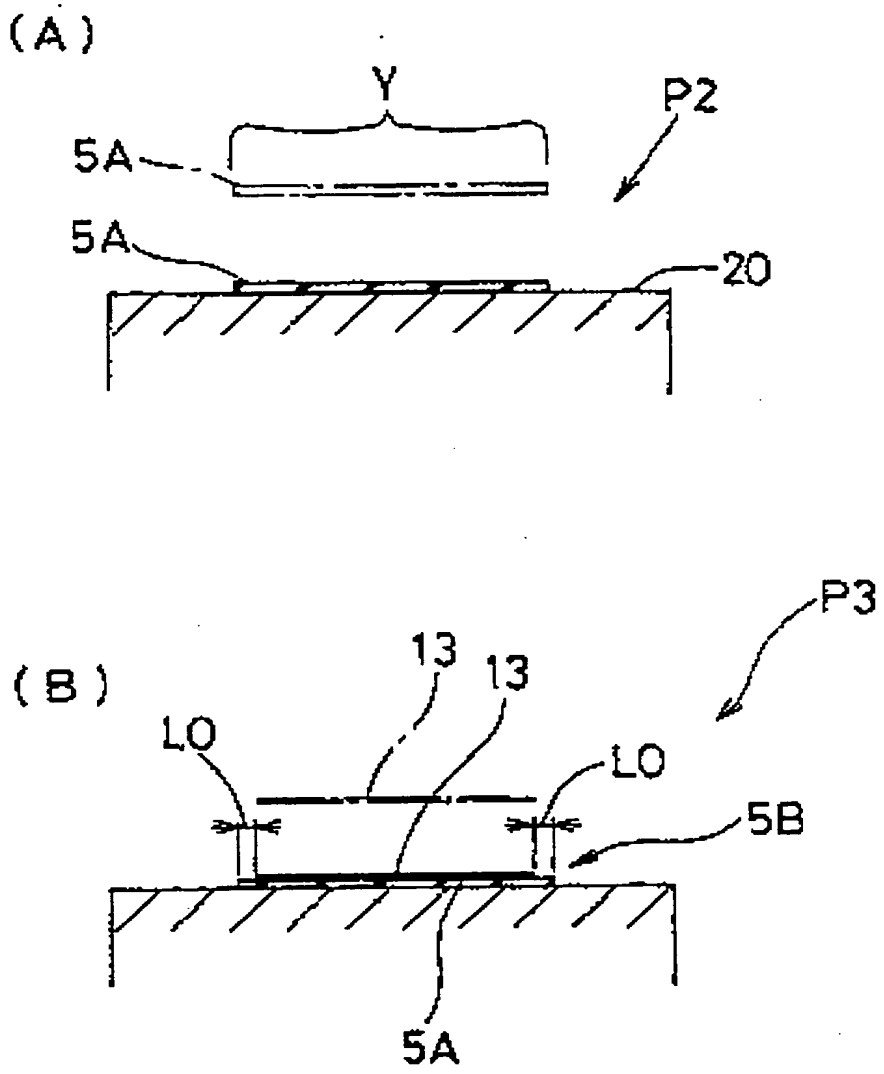


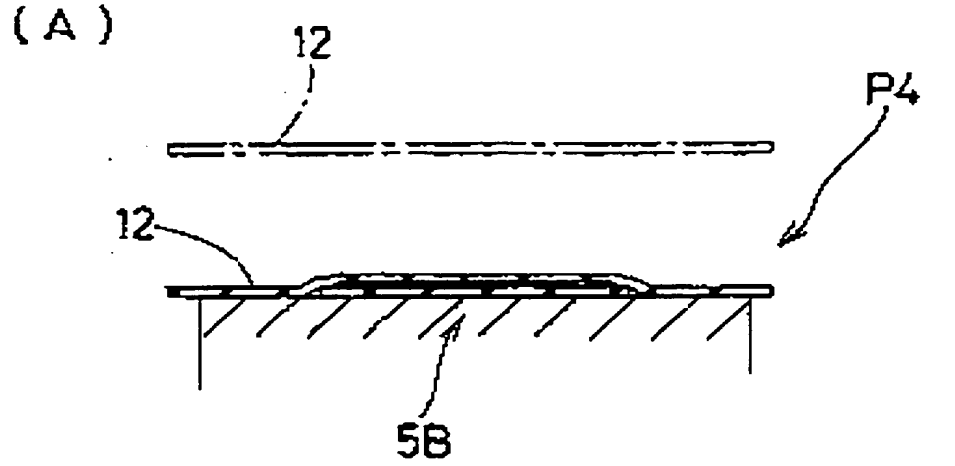
Fig.2

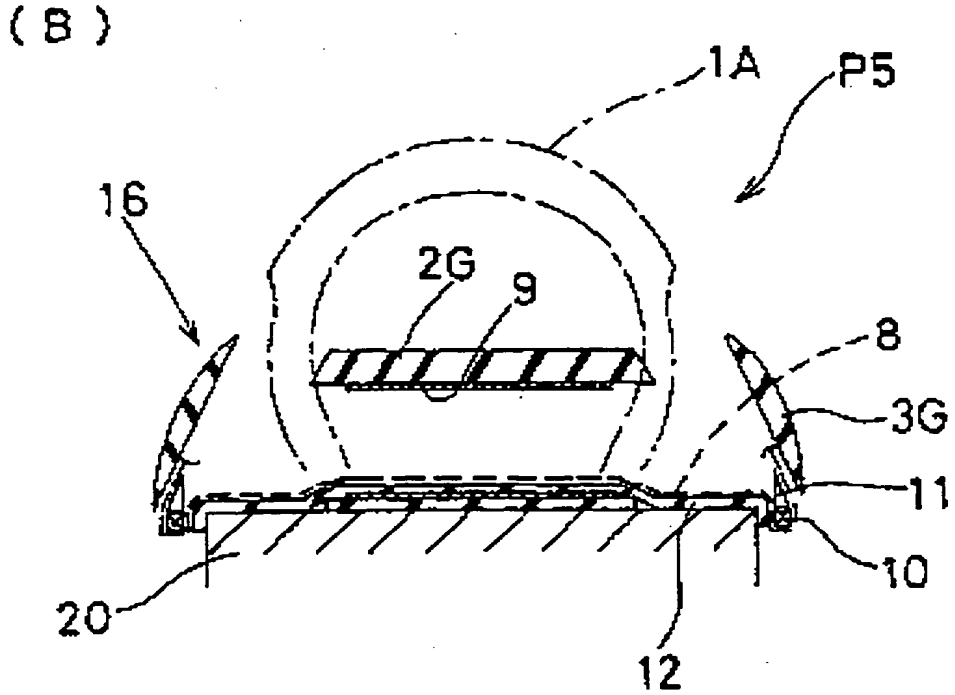


# Fig.3



# Fig.4



# Fig.5